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CONTENTS

Evidence Of Students' Performance In Expository Passages And Non-Mathematical Documents: Data From The Pilot Version Of The IEA Research Study
R. Moyana 1

Evidence Of Acquisition Of Reading Skill Related To Mathematics: Data From The International Literacy Study Pilot Testing: The Case Of Zimbabwe
G. Jaji 23

A Comparative Analysis Of Student Achievement By School Type In Zimbabwe Secondary Schools
L.M. Nyagura 43

Career Aspirations Of University Of Zimbabwe Geography Undergraduate Students And The Supply Of Graduate Geography Teachers
L.M Zinyama 62

Skilled Labour Markets In Zimbabwe: A Case Study Of Mechanical Engineering Personnel
P. Bennell, D. Katsidzira and F. Madziya 76

Evidence Of Acquisition Of Reading Skill Related To Mathematics: Data From The International Literacy Study Pilot Testing: The Case Of Zimbabwe

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Abstract

This study was carried out in 1989 as a part of the International Reading Literacy Pilot Study. A selected sample of 240 pupils in Form II during 1989 were administered the four forms of the pilot test. A number of the items were concerned with the reading of tables, including timetables and graphs, which is a specifically mathematical reading skill. These items were analyzed to gain an overview of the reading skills in mathematics possessed by Zimbabwean pupils. On the whole, it was found that these skills (which were specifically covered in the primary school mathematics syllabus) were acquired by the majority of pupils. This was quite encouraging since being able to read mathematics is so closely related to being able to learn mathematics. There was some concern, however, that those items which call for greater interpretation, extrapolation and analysis were less well done and again, as in other related studies, we see the weakness of the pupils in acquiring higher order processing skills. It is recommended that further research in this area be carried out and that greater emphasis be placed on the higher order processing skills so that pupils acquire problem solving skills.

Introduction

Being able to read mathematical materials is a very necessary skill. Posamentier and Stepelman (1986,p. 196) say, "Pupils who learn to read a mathematics textbook with confidence will have acquired the most valuable skill a math teacher can provide." They suggest comparing the reading of mathematics to reading recipes or instructions in do-it-yourself kits so that pupils will

see that they must understand each statement before moving to the next. Uprichard in the Foreword to *Teaching Reading and Mathematics* (Earle, 1976) says, "the mathematical development of children correlates highly with their ability to read mathematics. Further, the more meaningful the approach taken in learning mathematics the more important reading ability becomes."

Reading mathematics involves perceiving symbols, attaching literal meaning, analyzing relationships and solving word problems. Earle (1976) lists among the reading study skills for mathematics the reading of graphs, reading statistical tables, recognizing length and relationship of time periods.

Among the specific topics in the primary school mathematics syllabus (Min.Educ., 1984) in Zimbabwe are the reading and use of bus and train timetables, ready reckoners, tables and graphs. Thus, some aspects of the reading of mathematics are specifically catered for in the primary school mathematics syllabus. It is to the extent to which the objectives of teaching these skills is attained that this paper is directed.

Methodology

During October and November of 1989, a pilot English reading test was administered to 240 children selected from the Rural Day schools and other (government, church, and high fee) schools in Harare and Mashonaland East Provinces. The test was designed to assess the literacy level in terms of reading comprehension of pupils approximately 14 years of age. It consisted of four booklets (averaging 37 pages each) containing passages covering a wide spectrum of areas to be read followed by comprehension questions. Some items appeared in all four booklets while other items appeared in only one booklet.

The method of entering data selected only 60 pupils per booklet and thus the sample reflects a maximum N of 60 (in some cases fewer pupils responded) which is a per booklet number rather than a total number of children tested. Note that Bus timetables (see Table 1) and Population of Continents (see Table 6) appeared in all four booklets thus for these 2 items the number was 223 and not 60. The schools were selected on a stratified sample from the upper 10%, the lower 10%

in terms of 'O-level' results from 1987, etc. They were selected only from Harare and Mashonaland East on the basis of ease of access and thus are a preferred sample, not in any way a representative sample, but should exhibit all levels of performance in the skills tested. Performance on the sets of items which appeared in all booklets were substantially the same for all groups giving confidence that the sample created by the method of data entry was satisfactory, but even so the lack of randomness suggests caution when looking at the results.

For purposes of analysis only those items which had mathematical content were selected for this particular discussion which focuses upon the extent to which the pupils had been taught to read material which is specifically mathematical in nature.

Results

Reading A Bus Timetable

Table 1
Using A Bus Timetable

Question	Percentage obtaining correct answer overall	boys	girls
Time of first bus	75%	83%	71%
Time of second bus	73%	75%	71%
Time of arrival if bus missed	73%	79%	69%
Latest bus to catch for specific arrival time	61%	60%	64%
Best bus to take for specific arrival time	70%	72%	70%

N = 223

The reading of bus, train and airline timetables is a particular topic in the primary school syllabus with the topic taken up specifically as early as Grade 4 and the reading of class timetables beginning from Grade 2. Seventy-five percent of the 60 pupils included in the sample could answer the question on the when the first bus leaves a specific place. Note here that more boys are able to read the timetable than girls. Marginally fewer pupils (73%) answered correctly on the question concerning the time the second bus left a specific place. The question which required some inference (the time you would reach the city having missed a specific bus) was also done very well (73%). But here again the boys outperformed the girls with 79% of the boys doing this item correctly and only 69% of the girls. The question concerning the latest bus you could catch to arrive by a specific time was done less well (61%) -- note here that this question calls for more inference and is in a sense a problem solving type question. Also of interest here is the fact that marginally fewer boys answered this item correctly (60%) than girls (64%). Interestingly 70% were able to answer the question on the best bus to take to attend an early morning meeting which called for similar skills to those in the previous question. On the whole it is evident that for many pupils the instruction in reading timetables is paying off but it is still of some concern that about 25% of the pupils are not acquiring this useful skill.

Art (directions)

Table 2
Art (Following Directions)

Question	Percentage obtaining correct answer		
	Overall	Boys	Girls
Number of circles drawn	83%	76%	77%
Location	88%	92%	85%
Number of lines	82%	80%	82%
What is found in specific location	65%	68%	62%
How many lines	85%	76%	91%

N = 60

While this question is less specifically mathematical in nature and not a topic in the syllabus, it is of interest since the following of directions of this nature are important to learning mathematical constructions, etc. Eighty-three percent were able to follow the first direction of draw circles in the wings and then identify the number of circles drawn. Eighty-eight percent correctly followed the fourth direction and then identified what they had done. Eighty-two percent correctly followed the last step in the directions and identified the result. When the result of the direction was phrased in a different way only 65% were able to answer it correctly. Finally 85% were able to carry out steps 2 and 3 and identify what they had done correctly. Note that this item was answered correctly by a much greater percentage of girls (91%) than boys (76%). Thus, it is safe to conclude that the majority of students can carry out simple and precisedirections.

Weight (reading graphs)

Table 3
Weight (Reading A Graph)

Question	Percentage obtaining correct answer		
	Overall	Boys	Girls
Zone of graph	90%	84%	94%
Conclusion missing information	25%	24%	27%
Conclusion information available	23%	28%	21%
Interpretation of information	50%	52%	50%
Extrapolation and interpretation	23%	16%	29%
Drawing conclusions	32%	16%	41%

N=60

This is another specific topic taught in both the primary and secondary syllabuses in mathematics. Ninety percent of the sample were able to answer the first question which identified the vertical and horizontal position when they were called upon to identify where on the graph this fell. The girls appeared to have had a better grasp of this topic (94%) than boys (84%). Yet, only 25% could answer the question asking them to draw conclusions where insufficient information was given. This is a type of question that pupils rarely encounter in their school exercises and thus it is not surprising that the pupils fared so badly. However, it should be noted that this type of question is related to problem solving skills and pupils need experience with questions where they cannot draw conclusions without further information. The next question also showed poor performance levels with 23% answering correctly. This was again calling for conclusions, this time ones for which the information was available but for which there was also extraneous information which could mislead pupils. Again, a type of situation not often met in school exercises, but one which should be included. Fifty percent of the pupils were able to answer the one calling them to draw conclusions concerning height based on the known weight and zone. This question is much more in line with the type of questions pupils encounter in school exercises. The final question in this category was answered correctly by 32% of the pupils. The girls outperformed the boys on this item by a considerable margin (41% for girls to 16% for boys). This item called for a calculation based on graphic information and the majority of the pupils missing the question seem to have misread the graphic values. Clearly, the specific skills of reading graphs have been taught and learned by the pupils; yet, the ability to use graphs to solve problems remains outside the ability of many of the pupils due to the lack of emphasis on this aspect in the teaching of the topic.

Reading A Table

Table 4
Reading Tabular Data

Question	Percentage obtaining correct answer Overall	Boys	Girls
Locating information in table	88%	76%	97%
Locating numerical information	86%	76%	94%
Extrapolatinginformation	58%	68%	53%
Scanning for specific information	65%	72%	74%
Scan and combine information	52%	52%	50%

N = 60

Eighty-eight percent of the pupils in the sample were able to read information directly from the table. Eighty-six percent of the pupils were able to interpret the numerical data given in the table. On these first two items the girls did considerably better than the boys. Combining information in the table was done correctly by 58% of the pupils, 65% could scan the table for specific information and 52 % could scan and combine specific information from the table. Again, those items which call for interpretation and application were not as well done as those which involved merely finding direct information.

Docket (invoices)

Table 5
Reading Invoices

Question	Percentage obtaining correct answer		
	Overall	Boys	Girls
Finding items bought	97%	100%	91%
Location of company	62%	60%	62%
Date	95%	100%	91%
Amount spent on specific item	78%	72%	82%
Amount tendered	90%	96%	85%
Meaning of change due	97%	96%	97%

N = 60

Reading and making out invoices is also a part of the primary mathematics syllabus. Ninety-seven percent of the pupils could look at the docket and find the number of items bought. While 62% of the pupils answered the item on the name of the town correctly, it is important to note that the 38% who missed the item all made the mistake of thinking the Georgetown was the name of the town rather than the name of the shop. Ninety-five percent of the pupils correctly found and interpreted the date. Seventy-eight percent were able to find the specific amount paid for an item, 90% could identify the amount given in payment and 97% could interpret the meaning of change due. It is quite clear that most of the pupils have gained considerable mastery over invoice usage.

Continents (table reading)

Table 6
Reading A Numerical Table

Question	Percentage obtaining correct answer Overall	Boys	Girls
Finding the largest for specific year	86%	92%	84%
Finding population which grew least	78%	70%	84%
Find the year for specific population level of specific continent	94%	95%	94%
Find the year for specific population level	91%	90%	92%
Find when one expected to exceed another	22%	21%	23%
Find greatest population for particular year	83%	83%	81%
Year in which one continent population catches another	82%	83%	82%
Population which doubled	65%	72%	62%

N = 223

Another item on table reading concerned the populations of the continents over a period of about 100 years. As stated previously, table reading is taught as a specific part of the mathematics syllabus. Eighty-six percent of the pupils were able it identify the population which was largest for a specific year, 78% were able to identify the population which grew the least over a seventy year period, 94% could find the year in which the

population of a specific continent reached a specific level, 91% could answer a similar question on when a population was expected to reach a specific level, yet only 22% could find the period in which one population was expected to exceed the population of another continent. Eighty-three percent could find the greatest population for a particular year, 82% could find the year in which one continent's population caught up with that of another, and 65% could find the population which would double within a specific period. It is clear that most pupils are mastering the reading of tabular data yet may experience some difficulty with that data when called upon to problem solve or to make analytic interpretations.

Draw (following directions)

Table 7
Following Directions for Drawing

Question	Percentage obtaining correct answer Overall	Boys	Girls
Follow directions and identify results	71%	70%	72%
Sum numbers placed in specific location	77%	70%	81%
Find difference of numbers placed in specific location	77%	74%	78%
If the number in the lowest square is turned upside down, what does it become?	30%	44%	19%

N = 56

Seventy-one percent of the pupils in the sample could correctly follow the first two directions and then identify their results, 77% could combine the following of directions with a question calling for them to sum specific numbers, 77% could do the same with finding a difference; yet, only 30% could understand

the question "if the number in the lowest square is turned upside down, what does it become?" with most pupils turning the whole diagram upside down. Note here the much better performance of the boys on this item (44%) as compared to the girls (19%).

Temperature (tables and thermometers)

Table 8
Reading Tables And Thermometers

Question	Percentage obtaining correct answer		
	Overall	Boys	Girls
Time of highest temperature	84%	78%	88%
Read thermometer and chart	77%	70%	82%
Interpreting informationin chart	68%	57%	79%
Specific instances of an event	57%	50%	64%
Locating trends in table	75%	73%	76%

N = 57

Eighty-four percent of the pupils were able to find the highest temperature in the table, 77% were able to read the thermometer and connect this with a reading in the table, 68% were able to interpret when an event happened using the table, 57% were able to find specific instances of an event in the table, and 75% were able to locate a specific trend in the table. It can be seen that the majority of pupils are benefiting from the inclusion of these topics in the mathematics syllabus and are mastering the skills.

Graph (following directions)

Table 9
Graphing And Following Directions

Question	Percentage obtaining correct answer		
	Overall	Boys	Girls
Construct graph and locate specific information	74%	74%	77%
Read graph (how high A)	67%	58%	74%
Read graph (how high C)	64%	53%	74%
Height of furthest right rectangle	35%	21%	44%

N = 54

Constructing graphs is another specific skill covered in the primary mathematics syllabus and this item in mainly concerned with construction and interpretation of a graph. Seventy-four percent of the respondents were able to correctly construct the graph and locate specific information, 67% and 64% were able to correctly interpret the graph but only 35% could answer correctly the height of the furthest right rectangle. This particular item seems to indicate difficulty with interpreting the question.

Note here that the girls outperformed the boys on all items in this category.

Weather (table)

Table 10
Reading Weather Chart

Question	Percentage obtaining correct answer Overall	Boys	Girls
Locate high temperature for particular city	79%	90%	77%
Locate low for particular city	56%	47%	62%
Total specific condition for table	76%	68%	79%
Locate coldest place	43%	42%	44%
Locate hottest place	63%	63%	65%
Find number of places remaining below specific temperature	48%	47%	50%

N = 54

Seventy-nine percent of the pupils could find the high temperature for a particular city, 56% could find the low for a particular city, 76% could total a specific condition for the table, 43% could locate the coldest place, 63% could find the hottest place, and 48% could find the number of places that remained below a specific point. Pupils appear to have difficulty with this type of table and especially with combining and scanning the table for information.

Budget

Table 11
Budget

Question	Percentage obtaining correct answer Overall	Boys	Girls
Find total percentage of one part of budget	63%	74%	59%
Locate largest percentage	85%	90%	85%
Locate specific expenditure	93%	95%	91%
Compare two parts of budget	26%	26%	27%
Find smallest amount of income	69%	63%	71%
Compare two expenditures	72%	68%	74%
Find lower expenditures compared with specific expenditure	61%	63%	62%
Find second largest expenditure	52%	47%	53%

N = 54

This item is mainly table reading but combines knowledge of budgets which is a specific topic within the primary mathematics syllabus. Sixty-three percent of the pupils could total the percentage of one part of the budget, 85% could locate the largest percentage, 93% could locate a specific expenditure, yet only 26% could take two parts of the budget and compare them.

Sixty-nine percent could find the smallest amount of income, 72% could compare two expenditures, 61% could find the lower expenditures compared with a specific expenditure and 52% could find the second largest expenditure. Locating nonspecific information and comparing seems to cause the greatest difficulty and pupils probably need more experience along these lines to improve their performance.

Bread (numerical information)

Table 12
Nutritional Information In Chart Form

Question	Percentage obtaining correct answer Overall	Boys	Girls
Obtain information direct from chart	90%	90%	91%
Identify largest percentage	52%	47%	55%
Calculate percentage for 2 slices of bread (information no more than 1%)	10%	0%	15%
Interpretation of information in chart	83%	84%	82%

N = 52

The questions in this section deal with numerical information presented in a simple chart form. Percentages and units of mass are used. Obtaining information direct from the chart was successfully done by 90% of the pupils. Yet only 52% could identify the largest percentage given in the chart. It is in striking contrast to these previous performances that pupils were, for the most part, unable of deal with the item where they were to calculate the percentage for 2 slices of bread; only 10% were successful. Note, however, that it is apparent that this

question was quite difficult as no specific percentage was given and pupils were unable to interpret this type of situation. They would need specific instruction in interpreting this type of information as it is not of a type they regularly encounter.

The final question which was a very simple interpretation of the information in the chart was done correctly by 83% of the pupils.

Lynx (bar graph)

Table 13
Reading Bar Graphs

Question	Percentage obtaining correct answer Overall	Boys	Girls
Read information direct from bar graph	83%	84%	82%
Combine two pieces of information from bar graph	52%	42%	52%
Note general pattern and identifydeviation from it	37%	37%	34%
Interpret pattern information	38%	21%	49%
Prediction(no numerical information)	60%	63%	58%
Predict continuation of overall pattern	42%	42%	42%

N = 52

The making and interpretation of bar graphs is within the primary school mathematics syllabus. Eighty-three percent of the pupils were able to read information directly from the bar graph. Only 52% were able to combine two pieces of information from the graph. Being able to note the general pattern and

identify deviations from it was successfully done by only 37% of the pupils. A similar item calling for interpretation of pattern information was done successfully by only 38%. A prediction question devoid of specific reference to the chart and to numerical information was done successfully by 60% of the pupils. Forty-two percent of the pupils could successfully predict the continuation of the overall pattern.

Life (bar graph)

Table 14
Reading Bar Graph Two Pieces Of Information On Single Bar

Question	Percentage obtaining correct answer		
	Overall	Boys	Girls
Read information direct from chart (must separate the two pieces)	48%	42%	52%
Read information direct from chart(not necessary to separate)	58%	68%	52%
Make calculation based on graph	52%	53%	52%
Identify least improvement	37%	47%	30%
Extrapolateinformation	31%	37%	27%

N = 52

Another bar graph set of questions, but with a more complex presentation form, not usually covered in the primary syllabus in mathematics i.e. single bar with variant shading for two different year groups, proved much more difficult for the pupils.

a clear lack of mathematical estimation skill. The second had to do with reading the graph as if the bar carried single instead of double data. Fifty-eight percent were able to answer correctly when the question related to the distance shown on the full bar; thus, picking up many who made the error previously of reading the bar as single instead of double. Fifty-two percent were able to use the graph and make a calculation based on the information. Only 37% were able look at the overall information and make an interpretation concerning least improvement and only 31% could make an interpretation related to information not specifically shown in the graph. Thus we see the ability to handle the more rote knowledge skills far better developed than the interpretation and application skills which are vital for truly using the knowledge in the working world.

Trees (Flow chart diagram)

Table 15
Flow Chart

Question	Percentage obtaining correct answer		
	Overall	Boys	Girls
Information in fourth step	83%	84%	82%
Interpretive	69%	58%	76%
Increasedinterpretation	23%	16%	17%
Two steps	54%	53%	55%
Item done at specific stage	79%	68%	85%
Identify number of step at which particular even happened	77%	74%	79%
Identify final step	73%	74%	73%

N = 52

Use of flow charts is taught in the secondary syllabus but not in the primary syllabus. The direct knowledge question was answered successfully by 83% of the pupils, yet only 69% could successfully do an interpretive question. As the amount of interpretation increased the performance of the pupils went down and only 23% of the pupils could answer the question on number of steps completed before a certain event. A two step question of direct knowledge was done successfully by 54% of the pupils and 79% could read a direct item on what was done at a specific stage. Seventy-seven percent could identify the number of the step at which a particular thing happened and 73% could identify the final step.

Summary

It can be seen from the data that the pupils are indeed acquiring the necessary skills to read a variety of tables (timetables, ready reckoners, etc.), graphs and invoices. Thus, this aspect of the mathematics syllabus related to reading is being mastered by the majority of the pupils. While there is considerable variation in the questions answered correctly by boys and girls, there does not appear to be a consistent pattern of one sex outperforming the other in terms of reading mathematical material. However, this said, we must also note that difficulty is experienced in using their reading skill when interpretation and problem solving are involved and thus what has been a recurrent problem (see Jaji & Nyagura, 1989 & Jaji, 1990) in research on the knowledge of pupils in Zimbabwe in mathematics again crops up here, i.e. students acquire the mechanics of accomplishing the task but do not gain sufficient understanding of the underlying concepts to be able to use the ideas in problem solving. Thus, while we can be quite happy that our pupils are acquiring the necessary basic skills, we must not be satisfied with what is happening in our schools until pupils are able to apply that skill to interpretation, applications and problem solving. We need to look into ways in which pupils may be helped to acquire greater understanding. It is essential that research into the kinds of activities necessary to acquiring problem solving skills be undertaken.

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